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LED Microsensor NT

MDS-4
Methane Sensor Module
Instruction Manual

rev. 090915

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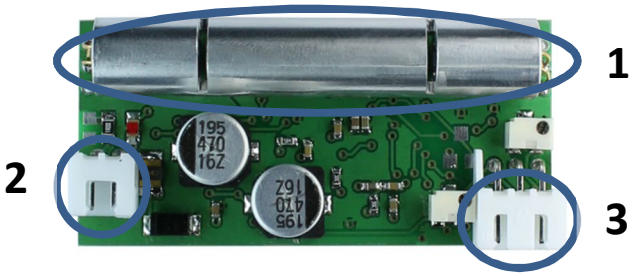
Application & Description

MDS-4 is a methane sensor module for CH_4 detection. It includes a compact optical cell and electronics for LED power supply and PD signal amplification all-in-one.

Features

- ✓ Diffusion type detection
- ✓ Measurement in 0-5% (volume) concentration range
- ✓ Resolution down to 250 ppm in 0-5% (volume) concentration range
- ✓ Very low power consumption – 3.5 mW
- ✓ Quick response time – <2 s
- ✓ Operating temperature range – 0..+40°C
- ✓ Size: 55x26x14 mm (including optical cell and circuitry)
- ✓ Gases: precalibrated for methane, but will respond to most hydrocarbons
- ✓ Possibility of integration with wireless data transfer protocols like Zigbee, WiFi, GPRS
- ✓ Possibility of power battery supply

Appearance & Layout



1. Optical cell with an LED Lms34LED-CG and a photodiode Lms36PD-05-CG
2. Power input
3. Temperature and measuring signal output

Temperature compensation

In the module there is realised a circuit for measurement of LED's operation voltage for temperature determination of the optical cell. It enables temperature compensation of measuring signal in 0...+40°C range.

Operation conditions

Indoor operation only. Ingress Protection Rating IP00.

INFORMATION ABOUT TUNING AND CALIBRATION

MDS-4 methane sensor module has two analogue signal outputs:

- U_T – temperature signal output
- U_{SD} – measuring signal output

Processing these 2 signals enables obtaining information about gas concentration.

The sensor module is precalibrated for methane measurement at LMSNT facilities. Precalibration procedure includes:

- obtaining dependence between U_{SD} and U_T in order to compensate temperature influence on the measuring signal and determine the level of optical signal attenuation defined by the gas concentration (but not by the temperature);
- obtaining dependence of methane concentration on the optical signal attenuation level.

The process of manufacturer's precalibration is described below.

1. The sensor is placed in a heat chamber, where it undergoes the temperature change from 0°C to 40°C range with 0.2°C/min. During this procedure signal values from U_T (temperature signal) and U_{SD} (measuring signal) are measured with 0.04°C resolution. Basing on this data array, the coefficients (a, b and c) for interpolating function of $U_{SD}=f(U_T)$ dependence are calculated:

$$U_{SD}^{calc} = \boldsymbol{a} + \boldsymbol{b} \times U_T + \boldsymbol{c} \times U_T^2 \quad (1)$$

2. Then the sensor is blown-through at a constant temperature (20°C) with a control gas mixture N_2+CH_4 with methane concentration C_{CH4} varied in the range from 0 to 5% vol. During this procedure signal values from U_{SD} (measuring signal) are measured and U_T (temperature signal) is controlled for stability. Using the U_{SD} data array and U_{SD}^{calc} value at T=20°C, the row of ΔS_{att} (level of optical signal attenuation) values is calculated:

$$\Delta S_{att} = 1 - \frac{U_{SD}}{U_{SD}^{calc}}$$

3. Basing on ΔS_{att} (level of optical signal attenuation) and known in advance methane concentration values C_{CH4}, the coefficients (d, e and f) for interpolating function of $C_{CH4}=f(\Delta S_{att})$ dependence are calculated:

$$C_{CH4} = \boldsymbol{d} + \boldsymbol{e} \times \Delta S_{att} + \boldsymbol{f} \times \Delta S_{att}^2 \quad (2)$$

This formula is the main formula for methane concentration measurement.

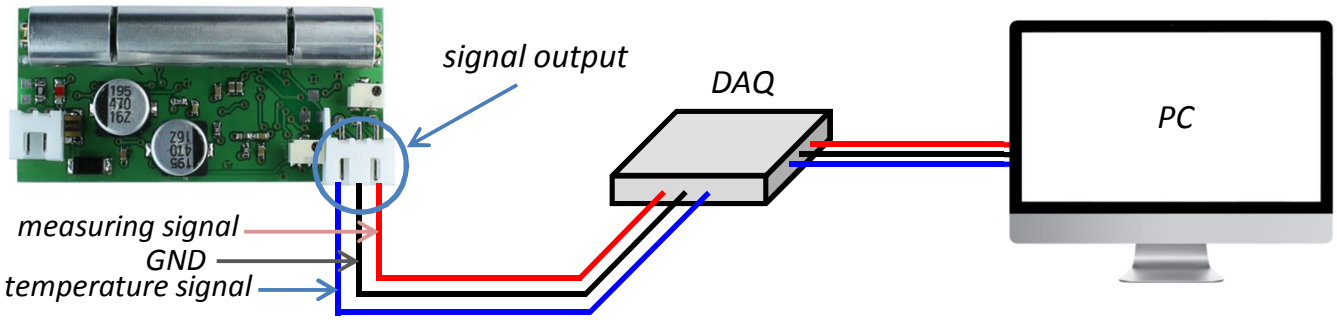
The resulting calibration coefficients (*a, b, c, d, e, f*) are pointed in the technical report provided with your MDS-4 module.

In order to treat the signals we recommend using a DAQ device and a PC for signal processing using the formulas above with calibration coefficients.

We recommend performing calibration checks annually. Sensor module recalibration procedure involves the adjustment of "*a*" coefficient only, all other coefficients remain unchanged. To define the recalibrated "*a*" coefficient value one needs to measure U_{SD} and U_T at a specific temperature with a zero methane level and use the following formula:

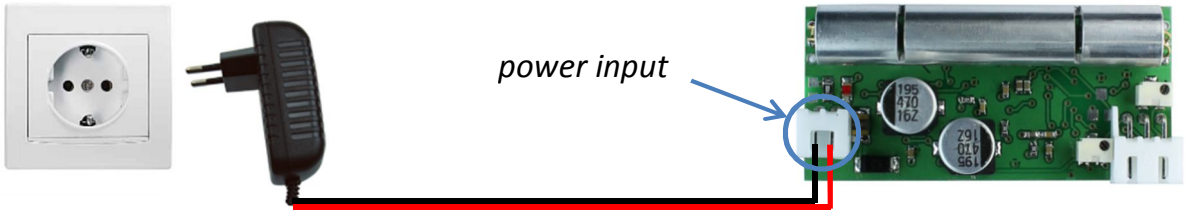
$$\boldsymbol{a_{recalibrated}} = U_{SD} - (\boldsymbol{b} \times U_T + \boldsymbol{c} \times U_T^2)$$

1. Connect the temperature and measuring signal output of MDS-4 module to a PC via a DAQ.



We recommend using the DAQ with analog input resolution at least 14-bit.

2. Connect the 3.3V stabilised DC power supply with the power input of MDS-4 module.



3. Use the formulas (1) and (2) from p. 4 for signal processing at your PC. The calibration coefficients (*a, b, c, d, e, f*) are pointed in the technical report appropriate to your MDS-4 module.

Precautions

⚠ Turn on the power supply only after all connections are made and tested.

⚠ Do not disassemble the optical cell; otherwise the optical system will be damaged.

⚠ Do not use multimeter to control and adjust current of the LED.

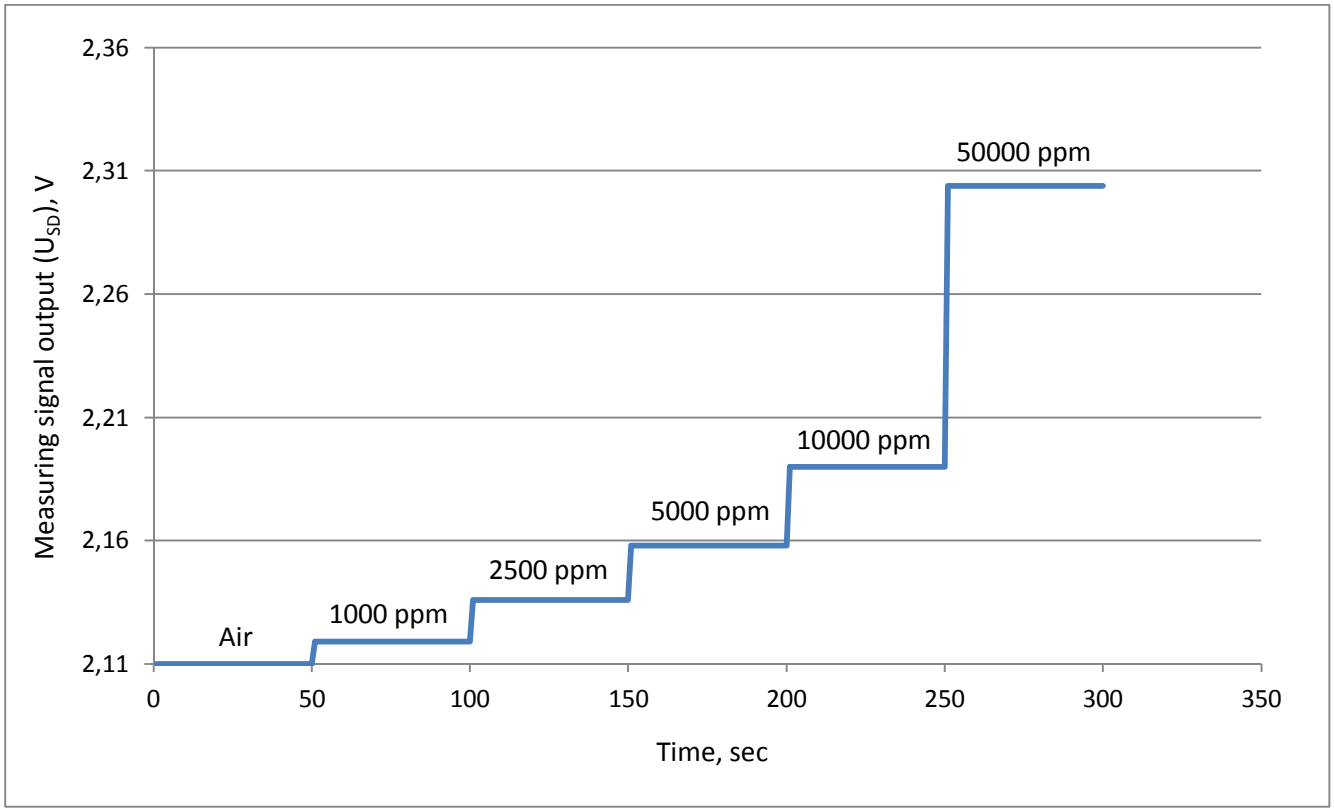
Note! Please refer to your provider if you have any questions.

Technical characteristics

Power supply voltage	+3.3 V, stabilized
Voltage tolerance	-5..+5 %
Power consumption	3.5 mW
Board dimensions	55x26x14 mm
Measuring output voltage signal amplitude	3 V
Temperature output voltage signal amplitude	3 V

MDS-4 testing results with different gas concentrations

Gas mixture	Methane concentration, ppm	Signal Output, V	Standard Deviation, mV	Noise, mV	Resolution, ppm
Air (Dry Bottled)	0	**2.110**	**2.17**	**7.58**	**-**
CH4 + N_2	1000	**2.119**			**252**
CH4 + N_2	2500	**2.136**			**237**
CH4 + N_2	5000	**2.158**			**253**
CH4 + N_2	10000	**2.190**			**303**
CH4 + N_2	50000	**2.304**			**632**



Relative signal change dependence on methane concentration
(U_{SD} signal output)